ISSN 0971-1554

JOURNAL OF QUANTITATIVE ECONOMICS

New Series Volume 10, No.1 — ***January, 2012***
Old Series Volume 26, No. 1 — *January, 2010*

JOURNAL OF QUANTITATIVE ECONOMICS

(Journal of the Indian Econometric Society)

New Series Volume 10, No. 1	***January, 2012***
Old Series Volume 26, No. 1	*January, 2010*

Managing Editor: **D.M. Nachane** and *Joint Managing Editors:* **G. Mythili and Rupayan Pal**

CONTENTS

Journal of Quantitative Economics, Vol. 10, No. (1), January 2012

ON THE RELATIONSHIP BETWEEN WORLD OIL PRICES AND GCC STOCK MARKETS

MOHAMED EL HEDI AROURI[1]
JAMEL JOUINI[2]
NHU TUYEN LE[3]
DUC KHUONG NGUYEN[4]

Abstract

We provide comprehensive evidence on the relationship between oil prices and stock markets for six GCC countries. Unlike previous contributions, a wide range of modern econometric techniques are applied in order to: i) capture both short- and long-term interactions between considered markets; ii) deal with the potential asymmetry in such interactions, and iii) control for the effects of relevant global financial variables. Empirical results show strong causal linkages in the short-run with the impact direction running usually from oil to stocks, but no long-run links based on standard cointegration analysis. Stock returns seem also to be more sensitive to negative than to positive oil shocks. Using the autoregressive distributed lags model as a robustness check for cointegration results, we find several significant cointegrating relationships between oil and stock prices.

Keywords: oil prices, stock markets, GCC countries, causal linkages, linear and nonlinear modeling.

JEL classifications: G12, F3, Q43

1. Introduction

The causal relationship between oil prices and stock markets has been recently investigated by a number of works given the importance of oil in industrial and real economic activity. The theory suggests that the rise of oil prices would cause aggregate stock prices to decrease since oil price fluctuations negatively affect real output which, in turn, lowers corporate

1 Professor of Finance, EDHEC Business School, 12 bis Rue de la Victoire, 75008 Paris, France, Email: Mohamed.Arouri@edhec.edu

2 Associate Professor of Econometrics, College of Business Administration, King Saud University, P.O. Box 2459 Riyadh 11451, Saudi Arabia, E-mail: jjouini@ksu.edu.sa

3 Associate Professor of Accounting, Law and Finance, Grenoble Ecole de Management, 12 rue Pierre Sémard, 38000 Grenoble, France, E-mail : nhu-tuyen.le@grenoble-em.com

4 **Corresponding author:** Associate Professor of Finance, ISC Paris School of Management, 22, Boulevard du Fort de Vaux, 75017 Paris, France, Email: dnguyen@iscparis.com

Acknowledgment: We would like to thank the editors and an anonymous referee for their valuable and helpful comments. All remaining errors are ours.

earnings (Hamilton 1983; Cunado and Perez de Garcia 2005; Cologni and Manera 2008; Lardic and Mignon 2008). Inversely, changes in stock markets may predict oil price movements to the extent that they represent the performance of the whole financial markets and reflect closely market conditions. There is, to date, empirical evidence that oil prices and stock markets exhibit some degree of interdependence. In a pioneer paper, Jones and Kaul (1996) examine the reaction of four well-established stock markets to oil shocks based on a standard present value model and find that the latter can be partially accounted for by the effect of oil price changes on the current and future cash-flows. Subsequent studies including, among the others, Huang et al. (1996), Sadorsky (1999), Papapetrou (2001), Basher and Sadorsky (2006), Anoruo and Mustafa (2007), and Park and Ratti (2008), reach similar conclusions using various methodologies such as Vector Autoregressive (VAR) model, international asset pricing models, and cointegration and Vector Error-Correction Model (VECM).[5] For example, Papapetrou (2001) find that oil price risk is priced in explaining stock price dynamics in the Greek market, while Basher and Sadorsky (2006) extend their research scope and empirical findings to emerging stock markets. In addition, Ciner (2001) documents the presence of nonlinear linkages between oil shocks and stock market returns in the US. Discussions of oil impacts on stock returns from a sectorial perspective can be found in Hammoudeh *et al.* (2004), and Nandha and Faff (2008).

In this paper our motivation is to provide comprehensive evidence on the existence and the nature of the dynamic relationships between oil prices and stock markets in the net oil-exporting countries of the Gulf Corporation Council (GCC). We investigate the potential of bi-directional oil-stock impacts in the six GCC countries (Bahrain, Kuwait, Oman, Qatar, United Arab Emirates, and Saudi Arabia) for the period 2005-2009. It is equally important to stress that, compared to oil-importing countries where the expected relation of oil to stock markets is negative (i.e., oil price increases lead to decrease real output and stock market returns), such relation in net oil-exporting countries is not clear-cut because the influence of oil shocks on national revenues, production activities, and corporate earnings are not always the same.

Our contributions to the related literature are in two principal aspects. First, there is still little empirical evidence on how oil prices are associated with stock markets in the context of the GCC countries (Hammoudeh and Aleisa 2004; Zarour 2006; Hammoudeh and Choi 2006; Maghyereh and Al-Kandari 2007). The investigation of such relationship in these countries is thus interesting because the GCC markets have recently become attractive to global investors seeking for international diversification benefits owing to their numerous structural reforms in the 1990s. Relevant results from the study also help governments and regulatory authority to make sound decisions when they have to regulate stock markets and oil price policies. Second, as shown in Table 1, empirical findings related to the oil-stock market relationship in the GCC countries are not consistent across past studies, albeit these countries share many features in common. Indeed, they can be characterized by highly oil-dependent economies and their stock markets by low level of market activity, financial depth and liquidity. Of the possible explanations for this divergence of results, we think that the differences in terms of methodological approaches,

[5] It is worth noting that Huang *et al.* (1996) document a significant link between some American companies' stock price changes and oil price movements, but the relationship between oil prices and stock market indices cannot be confirmed by their empirical results.

sample periods, and data used are important sources. This pattern thus renders impossible the comparison among related studies, and puts in advance the necessity for a comprehensive study that combines all methodologies and works on the same dataset to make final conclusions. Moreover, to the extent that the dynamic linkages between oil prices and stock markets may be subject to structural changes and nonlinearity as well, the use of linear models in most of the previous researches seems to be very restricted. For instance, the only one exception is Maghyereh and Al-Kandari (2007) who apply a nonlinear cointegration technique to oil and stock market data of the GCC countries, but these authors do not consider the possible structural changes as well as check for the robustness of their results using different data frequencies.

Table 1. Summary of Previous Studies on the Dynamic Linkages between Oil Price Movements and Stock Markets in the GCC Countries

Study	*Purpose*	*Sample markets*	*Study period*	*Empirical method*	*Key findings*
Hammoudeh and Aleisa (2004)	This paper investigates the effect of NYMEX WTI (West Texas Intermediate) oil futures returns on the GCC market returns	Bahrain, Kuwait, Oman, Saudi Arabia, and UAE	Daily data from February 15, 1994 to December 25, 2001	Vector Error-Correction (VEC) model	The authors suggest that most of the markets considered are sensitive to the movements of the NYMEX 3-month WTI futures price, but only Saudi Arabia has a bidirectional relationship with the oil price.
Zarour (2006)	This paper addresses the effect of the sharp oil price increases on stock market returns.	Bahrain, Kuwait, Oman, Saudi Arabia, and UAE	Daily data from May 25, 2001 to May 24, 2005	Vector Autoregressive (VAR) model	Changes in oil prices significantly affect stock market returns in all the markets, while only Saudi and Omani stock markets appear to have the predictive power of oil price movements.
Hammoudeh and Choi (2006)	This study examines the long-run interaction between five GCC stock markets and three global factors (oil spot price indices, US 3-month Treasury bill rate, and S&P index).	Bahrain, Kuwait, Oman, Saudi Arabia, and UAE	Weekly data from February 15, 1994 to December 28, 2004	Cointegration tests and VEC model	The oil price movements do not have direct effects on any GCC stock markets, while the latter counts for less than 4% of the variations in oil prices after a 20-week period.
Maghyereh and Al-Kandari (2007)	This paper focuses on the long-run analysis of oil-stock market linkages.	Bahrain, Kuwait, Oman, and Saudi Arabia	Daily data from January 1, 1996 to December 31, 2003	Rank tests for nonlinear cointegration analysis proposed by Breitung and Gourieroux (1997) and Breitung (2001)	The results support the hypothesis that oil prices affect stock markets in a nonlinear manner.

Hence, to the best of our knowledge, our study is the first attempt to reconcile the findings of previous studies based on various econometric techniques and a comprehensive dataset. We perform both short- and long-term analysis which allow for capturing not only nonlinear adjustments, but also structural changes in the dynamic interaction between oil prices and stock markets. Using weekly data from oil and stock market indices, the key empirical findings of this paper can be summarized as follows. Our short-term analysis shows some evidence of positive links between the two variables. The effects of oil price changes on stock returns in the GCC countries seem however to be asymmetric: negative oil price changes have larger impact on stock returns than positive oil price changes. In addition, our findings suggest that when causality exists, it runs from oil prices to stock markets in most cases. As for our long-term analysis, we show evidence of no long-term link between oil prices and stock markets in the GCC countries on the basis of Johansen (1988)'s cointegration framework, but significant cointegrating relationships from the autoregressive distributed lags model.

The remainder of the paper is structured as follows. Section 2 presents the data used and empirical modeling issues. Section 3 reports the empirical results. The policy implications of our results are discussed in Section 4. Some concluding remarks are provided in Section 5.

2. Data and Preliminary Results

This paper aims to provide comprehensive evidence on the relationship between oil prices and stock markets in the six member countries of the GCC. Our analysis thus considers the Qatari market, which is generally excluded in previous studies (see, Table 1). As in Hammoudeh and Choi (2006), we use weekly data because they seem to adequately capture the interaction between oil and stock prices in the region. Daily data are not used in order to avoid biases owing to time difference problems when dealing with international markets. Note for this purpose that GCC equity markets are generally closed on Thursdays and Fridays, while the developed and international oil markets close for trading on Saturdays and Sundays. In addition, for the common open days, the GCC markets close just before US stock and commodity markets open. As a result, we decide to use weekly data and choose Tuesday as the weekday for all variables considered because the latter lies in the middle of the three common trading days for all markets. It is equally important to remark that since the data used in all analysis predate the end of 2005 (Table 1), previous studies missed the spectacular evolutions that took place in the GCC and world oil markets in recent years. Therefore, our sample period goes from June 7, 2005 to December 31, 2009, and stock market data are market price indices provided by MSCI (Morgan Stanley Capital International).

As for oil, we use the weekly Brent spot prices, obtained from the US Energy Information Administration (EIA). Of the three types of oil prices commonly used in international petroleum trade (Brent, West Texas Intermediate, and Dubai), Brent oil serves as a reference price for almost two third of the world's crude-oil production including oil produced by the GCC countries, and pricing benchmark for many oil-related products and derivatives instruments. We also employ the MSCI world index and the US 1-month Treasury bill interest rate as control variables for the empirical relationship between oil and stock markets. These financial data are obtained from MSCI database. All data are measured in US dollar.

Table 2 summarizes the main descriptive statistics for our sample data (price and return series) and the results from some statistical tests. Overall, we observe that most stock returns are negative due to the international 2007-2009 financial crisis. On average, GCC stock markets have higher risk than the world market. Skewness is negative in most cases, except for Bahrain, and Kurtosis is significantly higher than 3 in almost all cases. The presence of these characteristics thus leads to the rejection of the normal distribution of all the return series with an exception for Kuwait. The Jarque-Bera test for normality confirms effectively this finding. We also carry out the Ljung-Box test for return autocorrelations of order 6 and the results show strong evidence of serial correlations for Bahrain, Oman and for the oil.

Table 2. Descriptive Statistics of Return Series and Their Stochastic Properties

Panel A: Log price series									
	Bahrain	*Kuwait*	*Oman*	*Qatar*	*Saudi A.*	*UAE*	*World*	*Brent oil*	*Interest*
Mean	4.512	4.994	4.658	4.630	4.475	4.478	4.836	4.256	1.206
Std. Dev.	0.146	0.203	0.228	0.247	0.267	0.211	0.124	0.272	0.500
Skewness	0.669	0.137	0.783	-0.112	0.431	0.206	-0.448	0.813	-1.622
Kurtosis	2.475	1.533	2.424	1.814	2.254	2.134	2.449	2.597	5.303
JB	15.2^{+++}	16.4^{+++}	20.5^{+++}	10.7^{+++}	9.6^{+++}	6.8^{++}	8.2^{++}	20.7^{+++}	116.8^{+++}
Q(6)	933.6^{+++}	964.6^{+++}	1011.0^{+++}	977.1^{+++}	902.2^{+++}	826.3^{+++}	791.3^{+++}	955.9^{+++}	732.8^{+++}
Panel B: Return series computed as $\ln(P_t/P_{t-1})$									
	Bahrain	*Kuwait*	*Oman*	*Qatar*	*Saudi A.*	*UAE*	*World*	*Brent oil*	*Interest*
Mean[a]	-0.0009	0.0024	$2.27*10^{-5}$	-0.0003	-0.003	-0.004	-0.001	0.002	-0.011
Std. Dev.	0.026	0.028	0.030	0.039	0.051	0.042	0.026	0.036	0.107
Skewness	0.490	-0.186	-0.971	-0.563	-1.113	-2.059	-3.893	-0.803	-4.086
Kurtosis	6.568	3.237	8.080	6.866	7.051	15.040	32.020	4.693	39.079
JB	100.4^{+++}	1.50	216.9^{+++}	118.9^{+++}	156.7^{+++}	1187.5^{+++}	6620.6^{+++}	39.9^{+++}	10035.7^{+++}
Q(6)	15.288^{++}	4.066	26.264^{+++}	7.520	4.890	7.874	5.193	27.369^{+++}	7.303
Panel C: Unconditional correlations for return series computed as $\ln(P_t/P_{t-1})$									
	Bahrain	*Kuwait*	*Oman*	*Qatar*	*Saudi A.*	*UAE*	*World*	*Brent oil*	*Interest*
Bahrain	1.000	0.232	0.300	0.250	0.203	0.308	0.181	0.062	0.112
Kuwait		1.000	0.294	0.251	0.271	0.348	0.092	-0.037	0.016
Oman			1.000	0.432	0.266	0.516	0.302	0.254	0.105
Qatar				1.000	0.361	0.618	0.168	0.374	0.230
Saudi A.					1.000	0.504	0.166	0.101	0.141
UAE						1.000	0.309	0.292	0.275
World							1.000	0.187	0.150
Brent oil								1.000	0.271
Interest									1.000

Notes: This table reports descriptive statistics for weekly log price and return series. The sample data covers stock market indices of six GCC countries, the World stock market index, Brent oil price index, and the US interest rate. JB refers to the empirical statistics of the Jarque-Bera test for normality based on skewness and excess kurtosis. Q(6) is the Ljung-Box test for autocorrelation of order 6. $^{+}$, $^{++}$ and $^{+++}$ indicate the rejection of null hypothesis of statistical tests at the 10%, 5% and 1% levels respectively. [a] indicate that coefficients are multiplied by 10.

Unconditional correlations among the GCC markets, MSCI World index, oil returns and US interest rate are shown in Panel C. Cross-market correlations of GCC stock and oil returns range from -0.037 (Kuwait/Brent) to 0.374 (Qatar/Brent). Only Kuwait has a negative correlation with oil returns. Stock returns on MSCI World index are positively associated with oil price changes. Correlations of the GCC markets with world stock market are relatively weak but in general higher than their correlations with Brent oil returns, except for Qatar. These findings suggest that the GCC stock markets are still segmented from the world oil and stock market trends, and as a result global investors can still get substantial benefits from adding both financial assets of the Gulf region and oil assets into their internationally diversified portfolios. To further apprehend the joint dynamics of Brent oil and the GCC stock market prices, we depict, in Figure 1, their time-paths over the study period. A high degree of time trend association is observed between April 2006 and January 2008, which thus indicates some interdependencies between these series.

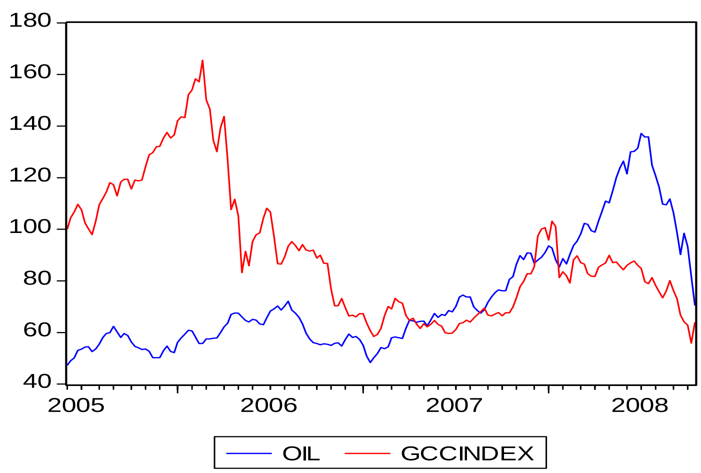

Figure 1. Oil Prices and GCC Stock Market Index

Before we can implement further analysis of the interactions between oil prices and stock market returns, two commonly used unit root tests including Phillips-Perron (PP) test, and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test are performed in order to examine the stationarity property of the series considered. The PP test is based on the null hypothesis of a unit root, while the KPSS test investigates the null hypothesis of no unit root. Summary results of these statistical tests for both price and return series are reported in Table 3. As expected, all the price series appear to be integrated of order one; *I*(1), while in almost all cases the hypothesis of stationarity cannot be rejected for the corresponding return series.[6] So, we can straightforwardly employ price series to investigate the long-term dependencies between variables of interest, and return series to examine the short-term linkages.

[6] Since our study period covers the recent global financial crisis 2007-2009, oil and stock returns series may be very instable. The unit root tests used in Table 3 might not be robust to the presence of potential outliers. Following the suggestion of the anonymous referee, we have first proceeded to replace the outliers in the price and returns series by their fitted values, obtained from applying the Maravall and Peña (1992)'s procedure, and then applied the PP and KPSS to the corrected price and returns series, The obtained results, available under request addressed to the corresponding author, are entirely similar to those we reported in Table 3. Thus, for our series, the presence of outliers does not alter the results from the PP and KPSS tests.

3. Empirical Evidence on the Oil-Stock Market Relationships

In this section, we report and discuss the empirical results regarding the sensitivity of stock markets to world oil price variations and inversely. We begin with the short-term analysis based on standard Granger causality tests, and VAR (Vector Autoregressive) modeling approach in order to compare the results across studies. Note that in this study we extend previous works by adding two control variables (World stock market and interest rate on 1-month US T-bill) to check for the robustness of the obtained results. As for the long-run analysis, we rely on the application of cointegration tests.

Table 3. Unit Root and Stationarity Test Results for Log Price and Return Series

	PP				*KPSS*	
	a	*b*	*c*		*b*	*c*
Log price series						
Bahrain	-0.416	-1.522	-2.115		0.948	0.259
Kuwait	1.007	-1.927	-1.078		1.397	0.154
Oman	-0.048	-1.142	-1.168		0.843	0.339
Qatar	-0.140	-1.278	-1.259		0.378	0.365
Saudi A.	-0.722	-1.101	-1.824		0.899	0.246
UAE	-0.952	-0.818	-1.301		0.527	0.301
World index	-0.308	-0.883	2.242		1.037	0.353
Brent oil	0.494	-1.663	-1.458		1.302	0.252
Interest rate	-0.698	1.866	0.178		0.960	0.407
Return series						
Bahrain	-10.813	-10.790	-10.760		0.184	0.179
Kuwait	-14.008	-14.038	-14.138		0.300	0.146
Oman	-10.868	-10.836	-10.807		0.202	0.217
Qatar	-11.869	-11.839	-11.809		0.160	0.176
Saudi A.	-11.723	-11.718	-11.681		0.117	0.119
UAE	-10.951	-10.985	-10.991		0.175	0.163
World	-12.183	-12.154	-12.685		0.731	0.163
Brent oil	-8.254	-8.250	-8.297		0.171	0.132
Interest rate	-14.245	-14.323	-14.941		0.653	0.068

Notes: PP, Philips-Perron tests; KPSS, Kwaitowski-Phillips-Schmidt-Shin tests. All variables are expressed in natural logs. (a) indicates a model without neither constant nor deterministic trend; (b) model with constant without deterministic trend; and (c) model with constant and deterministic trend respectively.

The PP test critical values are -2.578 (1%), -1.943 (5%) and -1.615 (10%) for the model a, -3.468 (1%), -2.878 (5%) and -2.575 (10%) for the model b, and -4.011 (1%), -3.435 (5%) and -3.142 (10%) for the model c. The KPSS test critical values are 0.739 (1%), 0.463 (5%) and 0.347 (10%) for the model b, and 0.216 (1%), 0.146 (5%) and 0.119 (10%) for the model c.

3.1 Granger Causality Tests

Granger causality is a specific form of causality in time-series analysis, which is based on the simple concept that a variable *X* Granger-causes *Y* if *Y* can be better predicted using the past values of both *X* and *Y* than it can using solely the past values of *Y*. Accordingly, Granger causality test is thus a simple and suitable way for us to assess the statistical causality between oil price changes and stock returns in the GCC countries. We employ the direct Granger method by regressing each variable on its own past values and those of the other, and by using the *F*-test to examine the null hypothesis of no-causality. Since considered variables and their bilateral effects are likely to be sensitive to the choice of lag number in regression models, we decide to implement this test for different lags. Table 4 reports the obtained results.

The results typically show that, in the short-run, stock market returns in Qatar and UAE are significantly Granger-caused by oil price shocks at the conventional levels whatever the lag being considered. The “oil to stock” causal direction is significant in Bahrain for the third lag at the 10% level. We also find evidence of significant causality from stock market returns to oil price changes in Oman for all the lags under consideration, in Kuwait for the first lag, and in the UAE for the first two lags. There is, in addition, absence of causal interactions between world oil and stock markets in Saudi Arabia.

Table 4. Causal Relationships between Raw Returns on World Oil and Stock Markets

Lags	*1*	*2*	*3*	*4*	*5*	*6*
Bahrain						
S→O	0.405	1.447	1.413	1.560	1.280	1.400
	(0.525)	(0.238)	(0.241)	(0.187)	(0.275)	(0.218)
O→S	2.135	1.154	**2.179**	1.705	1.454	1.311
	(0.146)	(0.318)	**(0.092)**	(0.151)	(0.208)	(0.255)
Kuwait						
S→O	**4.347**	2.330	1.962	1.618	1.513	1.644
	(0.038)	(0.101)	(0.122)	(0.172)	(0.188)	(0.138)
O→S	0.373	0.775	1.332	1.250	1.292	1.386
	(0.542)	(0.462)	(0.266)	(0.292)	(0.270)	(0.223)
Oman						
S→O	**10.710**	**5.923**	**3.395**	**2.500**	**2.871**	**3.361**
	(0.001)	**(0.003)**	**(0.019)**	**(0.045)**	**(0.016)**	**(0.004)**
O→S	1.372	0.566	1.731	1.392	1.019	0.973
	(0.243)	(0.568)	(0.163)	(0.239)	(0.408)	0.445
Qatar						
S→O	1.542	1.102	0.842	0.837	1.021	1.144
	(0.216)	(0.334)	(0.472)	(0.503)	(0.407)	(0.339)
O→S	**8.035**	**4.374**	**3.605**	**2.633**	**2.785**	**2.203**
	(0.005)	**(0.014)**	**(0.015)**	**(0.036)**	**(0.019)**	**(0.045)**
Saudi A.						
S→O	0.382	0.990	0.582	0.506	0.396	0.323
	(0.537)	(0.374)	(0.628)	(0.731)	(0.851)	(0.924)
O→S	0.188	1.201	1.380	1.043	0.782	0.690
	(0.665)	(0.303)	(0.251)	(0.387)	(0.564)	(0.658)
UAE						
S→O	**4.359**	**2.457**	1.997	1.704	1.171	1.067
	(0.038)	**(0.089)**	(0.116)	(0.152)	(0.326)	(0.385)
O→S	**2.910**	**7.470**	**6.372**	**4.762**	**4.406**	**3.680**
	(0.090)	**(0.001)**	**(0.001)**	**(0.002)**	**(0.001)**	**(0.002)**

Notes: This table reports the results of Granger causality tests applied to raw returns on oil and stock markets. S→O designates the causal impact from stock market returns to oil price changes, and O→S the causal impact from oil price changes to stock market returns at different lags. The *p*-values are reported in parenthesis.

However, some recent papers have shown that the link between oil and economic activity is not entirely linear and that negative and positive oil price shocks tend to have different impacts on economic growth (Hamilton 2003; Zhang 2008; Cologni and Manera 2009). Thus, we should expect that oil prices equally affect stock markets in a nonlinear fashion. In Tables 5-7, we show the causal relationship between stock market returns on the one hand, and positive oil shocks, negative oil shocks and net oil shocks on the other hand, respectively.[7]

[7] The net oil shock is defined as the difference between the observed return in period t and the largest return over the four last weeks.

A close inspection of the results in Table 5 indicates a lower degree of oil-stock causality in that world oil and stock markets in Bahrain and Kuwait do not Granger-cause each other, as compared to what is found in Table 4. Moreover, the bi-directional causal effects become significant only for some lags in Oman and Qatar. When negative oil shocks are accounted for, the patterns of oil-stock causality is similar to those we display in Table 4, but the causal linkage seems to be particularly pronounced. As for net oil price shocks, we find some weak causality from stock market to oil prices for Kuwait, Qatar and UAE. Taken together, stock returns in the GCC countries appear to asymmetrically respond to oil price decreases and increases. The higher sensitivity of stock returns to negative oil shocks can be easily explained by lower corporate earnings due to the decline in industrial production activity.

Table 5. Causal Relationships between Stock Returns and Positive Oil Shocks

Lags	*1*	*2*	*3*	*4*	*5*	*6*
Bahrain						
$S \rightarrow O^+$	0.097 (0.756)	2.137 (0.121)	1.394 (0.246)	1.074 (0.371)	1.258 (0.285)	1.016 (0.417)
$O^+ \rightarrow S$	0.779 (0.379)	0.610 (0.544)	1.752 (0.158)	1.338 (0.258)	1.241 (0.292)	1.332 (0.246)
Kuwait						
$S \rightarrow O^+$	1.773 (0.185)	0.917 (0.401)	1.784 (0.152)	1.251 (0.292)	1.007 (0.415)	0.990 (0.434)
$O^+ \rightarrow S$	0.212 (0.646)	0.327 (0.722)	0.650 (0.584)	0.575 (0.681)	1.111 (0.356)	1.206 (0.306)
Oman						
$S \rightarrow O^+$	**4.052** **(0.046)**	**2.796** **(0.064)**	1.581 (0.196)	1.088 (0.364)	1.058 (0.386)	1.228 (0.294)
$O^+ \rightarrow S$	0.293 (0.589)	0.057 (0.945)	0.616 (0.605)	0.516 (0.724)	0.495 (0.779)	0.577 0.749
Qatar						
$S \rightarrow O^+$	2.139 (0.145)	1.319 (0.270)	0.843 (0.472)	0.789 (0.534)	1.105 (0.360)	1.127 (0.349)
$O^+ \rightarrow S$	**3.984** **(0.047)**	**2.718** **(0.069)**	**2.255** **(0.084)**	1.725 (0.147)	1.317 (0.259)	1.069 (0.383)
Saudi A.						
$S \rightarrow O^+$	0.267 (0.606)	1.222 (0.297)	0.724 (0.539)	0.621 (0.648)	0.488 (0.785)	0.496 (0.811)
$O^+ \rightarrow S$	0.888 (0.347)	1.863 (0.158)	1.467 (0.225)	1.056 (0.380)	0.809 (0.545)	0.895 (0.500)
UAE						
$S \rightarrow O^+$	1.502 (0.222)	1.002 (0.369)	0.762 (0.517)	0.616 (0.652)	0.521 (0.760)	0.607 (0.724)
$O^+ \rightarrow S$	**2.955** **(0.087)**	**8.081** **(0.001)**	**5.493** **(0.001)**	**4.140** **(0.003)**	**3.376** **(0.006)**	**3.184** **(0.006)**

Notes: This table reports the results of the Granger causality test applied to GCC stock market returns and oil price increases. $S \rightarrow O^+$ designates the causal impact from stock market returns to oil price increases, and $O^+ \rightarrow S$ the causal impact from oil price increases to stock market returns at different selected lags. The associated *p*-values are reported in parenthesis.

Table 6. Causal Relationships between Stock Returns and Negative Oil Shocks

Lags	*1*	*2*	*3*	*4*	*5*	*6*
Bahrain						
S→O⁻	1.420	1.081	1.242	**2.437**	1.560	**1.847**
	(0.235)	(0.342)	(0.296)	**(0.049)**	(0.174)	**(0.093)**
O⁻→S	2.500	1.445	1.491	1.400	1.136	0.923
	(0.116)	(0.239)	(0.219)	(0.236)	(0.343)	(0.480)
Kuwait						
S→O⁻	**3.162**	1.692	**2.382**	1.749	**1.903**	**1.871**
	(0.077)	(0.187)	**(0.071)**	(0.142)	**(0.097)**	**(0.089)**
O⁻→S	2.069	2.157	**2.195**	1.903	1.724	1.511
	(0.152)	(0.119)	**(0.090)**	(0.112)	(0.132)	(0.178)
Oman						
S→O⁻	**9.875**	**4.991**	**3.325**	**2.547**	**3.108**	**3.321**
	(0.002)	**(0.008)**	**(0.021)**	**(0.041)**	**(0.010)**	**(0.004)**
O⁻→S	2.038	1.044	2.088	1.648	1.264	1.111
	(0.155)	(0.354)	(0.104)	(0.165)	(0.282)	0.358
Qatar						
S→O⁻	0.299	0.276	0.375	0.430	0.591	0.593
	(0.585)	(0.759)	(0.771)	(0.787)	(0.706)	(0.736)
O⁻→S	**7.134**	**3.577**	**2.771**	1.942	**3.239**	**2.844**
	(0.008)	**(0.030)**	**(0.043)**	(0.106)	**(0.008)**	**(0.012)**
Saudi A.						
S→O⁻	0.054	0.241	0.142	0.315	0.251	0.263
	(0.817)	(0.786)	(0.935)	(0.868)	(0.937)	(0.953)
O⁻→S	0.030	0.237	0.682	0.702	0.724	0.553
	(0.862)	(0.789)	(0.564)	(0.592)	(0.607)	(0.767)
UAE						
S→O⁻	**3.968**	**2.504**	**2.697**	**2.119**	1.330	1.120
	(0.048)	**(0.085)**	**(0.048)**	**(0.081)**	(0.254)	(0.353)
O⁻→S	1.330	**2.776**	**3.953**	**3.079**	**3.176**	**2.865**
	(0.250)	**(0.065)**	**(0.009)**	**(0.018)**	**(0.009)**	**(0.011)**

Notes: This table reports the results of the Granger causality test applied to GCC stock market returns and oil price decreases. S→O⁻ designates the causal impact from stock market returns to oil price decreases, and O⁻→S the causal impact from oil price decreases to stock market returns at different selected lags. The associated *p*-values are reported in parenthesis.

3.2 Oil-stock's Causal Relationships within VAR Models

The bivariate vector autoregressive (VAR) model is a useful alternative to the direct causality test we presented previously. Since the unrestricted-form VAR analysis treats simultaneously all variables as endogenous, the results of Granger causality tests within a bivariate VAR system are considerably more general and reliable as compared to univariate case. We can further detect feedback relations among the series through impulse response functions and variance decomposition.[8] Given that the Akaike Information Criterion (AIC) chooses one lag for all bivariate VAR systems, we then estimate six VAR(1) models and present the obtained results in Table 8.

---

8 See Sims (1980) for a rigorous discussion of the VAR analysis.

Table 7. Causal Relationships between Stock Returns and Net Oil Shocks

Lags	*1*	*2*	*3*	*4*	*5*	*6*
Bahrain						
S→ONet	0.013	0.171	0.109	0.246	0.087	0.322
	(0.911)	(0.843)	(0.955)	(0.912)	(0.994)	(0.925)
ONet→S	0.440	0.261	0.532	0.735	0.642	0.525
	(0.508)	(0.770)	(0.661)	(0.569)	(0.668)	(0.789)
Kuwait						
S→ONet	1.833	1.167	1.072	0.909	1.648	**1.879**
	(0.178)	(0.314)	(0.363)	(0.460)	(0.151)	**(0.089)**
ONet→S	2.096	1.244	0.920	0.757	0.709	1.097
	(0.150)	(0.291)	(0.433)	(0.555)	(0.617)	(0.367)
Oman						
S→ONet	0.749	0.998	0.807	0.772	0.968	1.284
	(0.388)	(0.371)	(0.492)	(0.545)	(0.439)	(0.268)
ONet→S	0.483	1.666	1.675	1.273	0.876	0.918
	(0.488)	(0.192)	(0.175)	(0.283)	(0.499)	0.484
Qatar						
S→ONet	**5.221**	**2.852**	1.801	**3.042**	**2.321**	**2.090**
	(0.024)	**(0.061)**	(0.149)	**(0.019)**	**(0.046)**	**(0.058)**
ONet→S	0.293	0.573	0.491	0.487	0.449	0.459
	(0.589)	(0.565)	(0.689)	(0.746)	(0.814)	(0.837)
Saudi A.						
S→ONet	1.677	1.672	1.311	1.448	1.506	1.392
	(0.197)	(0.191)	(0.273)	(0.221)	(0.191)	(0.221)
ONet→S	0.096	0.050	0.240	0.550	0.448	0.923
	(0.757)	(0.952)	(0.868)	(0.699)	(0.814)	(0.480)
UAE						
S→ONet	1.951	**2.779**	2.008	1.459	0.917	0.918
	(0.164)	**(0.065)**	(0.115)	(0.217)	(0.471)	(0.484)
ONet→S	0.525	0.482	0.603	0.913	0.735	1.369
	(0.470)	(0.619)	(0.614)	(0.458)	(0.598)	(0.231)

Notes: This table reports the results of the Granger causality test applied to GCC stock market returns and net oil price changes. S→ONet designates the causal impact from stock market returns to net oil price measure, and ONet→S the causal impact from net oil price measure to stock market returns at different selected lags. The associated *p*-values are reported in parenthesis.

Table 8. Results of VAR(1) Model Estimation for Oil and Stock Returns

Bahrain	*Stock returns*	*Oil returns*	**Kuwait**	*Stock returns*	*Oil returns*	**Oman**	Stock returns	Oil returns
Stock returns (-1)	**0.187**	0.062	Stock returns (-1)	-0.041	**0.194**	Stock returns (-1)	**0.175**	**0.281**
	(2.512)	(0.620)		(-0.555)	**(2.112)**		**(2.297)**	**(3.273)**
Oil returns (-1)	0.079	**0.377**	Oil returns (-1)	0.041	**0.381**	Oil returns (-1)	0.077	**0.319**
	(1.426)	**(5.066)**		(0.698)	**(5.202)**		(1.157)	**(4.283)**
Qatar	*Stock returns*	*Oil returns*	**Saudi Arabia**	*Stock returns*	*Oil returns*	**UAE**	Stock returns	Oil returns
Stock returns (-1)	0.028	0.086	Stock returns (-1)	0.093	0.031	Stock returns (-1)	**0.149**	**0.128**
	(0.343)	(1.226)		(1.192)	(0.589)		**(1.911)**	**(2.033)**
Oil returns (-1)	**0.259**	**0.341**	Oil returns (-1)	0.041	**0.374**	Oil returns (-1)	0.150	**0.331**
	(2.809)	**(4.222)**		(0.365)	**(4.965)**		(1.564)	**(4.269)**

Notes: This table reports the estimation results of a 2-variable VAR(1) model for stock market returns in each GCC country and world oil returns. Empirical *t*-statistics are reported in parenthesis. Coefficients which are significant at conventional levels are marked by a bold character.

Ignoring constant terms, the most important results pertain to the coefficients related to lagged values of explanatory variables as well as those of explained variables themselves.

Accordingly, we learn from these coefficients that stock returns in the GCC countries have a substantial influence on oil returns in three countries (Kuwait, Oman and UAE), while the inverse direction of causality does occur in only one market (Qatar). This finding, which does not seem to corroborate with the results of univariate Granger causality tests, indicates very weak causal relations between world oil and stock markets. Note also that it typically contrasts the results by Hammoudeh and Aleisa (2004), and Zarour (2006) providing empirical evidence to suggest that oil price changes significantly affect stock returns in almost all GCC markets. The use of weekly data instead of daily data may be the reason for explaining this difference.

We also check the robustness of the above-mentioned results by introducing two control variables (i.e., returns on world stock market index and growth rate of US 1-month T-bill interest rate) into the existing 2-variable VAR(1) systems. They are treated both as endogenous and exogenous. Table 9 present the results. It is observed that the oil-stock causal relations are not different from the results in Table 8. In particular, oil price movements are, not surprisingly, found to be positively affected by world market returns, and negatively by interest rate changes in al markets. As such, the rise in US short-term interest rates leads to decrease oil prices because it has negative effects on industrial activity, and reduces the world's demand for oil.[9]

We now analyse the short-run dynamics of the stock market and oil returns by using the generalized impulse response functions which estimate the response of a variable to shock in another variable at some time horizons.[10] The impulse response functions of stock and oil returns without and with control variables are shown in Figures 2 and 3 respectively. They indicate that the responses of stock market returns in the GCC countries to a one standard deviation (SD) of innovations in Brent oil returns and the responses of Brent oil returns to a one SD of innovation in GCC stock market returns follow almost similar patterns for all countries. Indeed, the inspection of Figure 2 shows that a positive shock to oil returns (stock returns) begins affecting the stock returns (oil returns) after the first period (1st week), and the reaction to shock disappears from the 5th week. The sole exception is Kuwait where we find a negative reaction from stock returns (oil returns) to standardized innovations in oil returns (stock returns) within the first period. The same conclusions can be drawn when world market returns and interest rate are introduced into the VAR system (Figure 3).

---

9 We have also estimated a VAR model with positive, negative and net oil changes instead of the oil returns series (the results are not reported here to keep the paper short). The results for the positive oil changes indicate that when ignoring the control variables, the drawn conclusions are the same for Bahrain and Saudi A. and slightly affected for the other countries in comparison with the case where the oil returns series is included in the analysis. When introducing the control variables, there are some changes in the results in terms of significance of the variables. For the negative oil changes, the conclusions are the same for Bahrain, Oman, Qatar and Saudi A. when only the oil and stock variables are introduced in the VAR system. However, for the other cases the results show some differences in comparison with the case where the oil returns are considered as endogenous variable. For the case of net oil changes, the conclusions are changed except for Bahrain and Saudi A. when the VAR system is estimated without taking into account the control variables.

10 Unlike the Cholesky factorization used to obtain the orthogonalized impulse response functions, we determine here the generalized versions, which do not depend on the ordering of the variables in the VAR system. Consequently, the obtained results produce the same conclusions.

Table 9. Results of VAR(1) Model Estimation for Oil and Stock Returns in Presence of Control Variables

Bahrain	Stock returns	Oil returns	World return	US T-bill rate
Stock returns (-1)	**0.190**	0.020	**-0.150**	0.159
	(2.494)	(0.208)	**(-1.900)**	(0.503)
Oil returns (-1)	0.081	**0.340**	0.012	0.220
	(1.396)	**(4.618)**	(0.200)	(0.915)
World returns (-1)	-0.032	**0.427**	0.094	**1.001**
	(-0.412)	**(4.349)**	(1.179)	**(3.127)**
US T-bill rate (-1)	**0.005**	**-0.053**	-0.001	**-0.154**
	(0.252)	**(-2.222)**	(-0.025)	**(-1.996)**

Kuwait	Stock returns	Oil returns	World return	US T-bill rate
Stock returns (-1)	-0.050	**0.168**	-0.078	0.240
	(-0.676)	**(1.930)**	(-1.086)	(0.837)
Oil returns (-1)	0.005	**0.344**	0.007	0.228
	(0.088)	**(4.717)**	(0.116)	(0.951)
World returns (-1)	0.081	**0.416**	0.079	**1.004**
	(0.993)	**(4.311)**	(0.988)	**(3.163)**
US T-bill rate (-1)	0.031	**-0.053**	-0.004	**-0.152**
	(1.553)	**(-2.265)**	(-0.188)	**(-1.973)**

Oman	Stock returns	Oil returns	World return	US T-bill rate
Stock returns (-1)	0.123	**0.205**	**-0.151**	0.034
	(1.574)	**(2.340)**	**(-2.151)**	(0.120)
Oil returns (-1)	0.045	**0.307**	0.033	0.218
	(0.661)	**(4.158)**	(0.550)	(0.891)
World returns (-1)	**0.224**	**0.368**	0.118	**1.014**
	(2.472)	**(3.717)**	(1.445)	**(3.088)**
US T-bill rate (-1)	0.005	**-0.053**	-0.004	**-0.151**
	(0.240)	**(-2.274)**	(-0.184)	**(-1.957)**

Qatar	Stock returns	Oil returns	World return	US T-bill rate
Stock returns (-1)	0.022	0.091	**-0.100**	0.112
	(0.274)	(1.343)	**(-1.817)**	(0.505)
Oil returns (-1)	**0.233**	**0.304**	0.050	0.178
	(2.466)	**(3.873)**	(0.775)	(0.692)
World returns (-1)	**0.213**	**0.423**	0.080	**1.016**
	(1.831)	**(4.365)**	(1.014)	**(3.200)**
US T-bill rate (-1)	-0.013	**-0.057**	0.002	**-0.157**
	(-0.451)	**(-2.407)**	(0.083)	**(-2.012)**

Saudi Arabia	Stock returns	Oil returns	World return	US T-bill rate
Stock returns (-1)	0.101	0.024	-0.058	0.062
	(1.260)	(0.478)	(-1.416)	(0.376)
Oil returns (-1)	0.060	**0.337**	0.018	0.213
	(0.506)	**(4.545)**	(0.300)	(0.882)
World returns (-1)	-0.078	**0.426**	0.082	**1.014**
	(-0.504)	**(4.366)**	(1.036)	**(3.184)**
US T-bill rate (-1)	-0.009	**-0.054**	-0.001	**-0.155**
	(-0.242)	**(-2.258)**	(-0.005)	**(-1.990)**

UAE	Stock returns	Oil returns	World return	US T-bill rate
Stock returns (-1)	0.132	**0.105**	**-0.139**	0.352
	(1.613)	**(1.657)**	**(-2.710)**	(0.708)
Oil returns (-1)	0.137	**0.312**	0.046	0.127
	(1.406)	**(4.155)**	(0.764)	(0.519)
World returns (-1)	**0.252**	**0.393**	0.121	**0.900**
	(1.969)	**(3.970)**	(1.512)	**(2.788)**
US T-bill rate (-1)	-0.036	**-0.061**	0.008	**-0.180**
	(-1.149)	**(-2.538)**	(0.390)	**(-2.299)**

Notes: This table reports the estimation results of a 4-variable (oil and stock market returns) VAR(1) model for each GCC country in the sample data. Empirical t-statistics are reported in parenthesis.

We have also computed the impulse response functions using the positive, negative and net oil shocks instead of the oil returns.[11] Similar results are obtained for the case of positive oil shocks for Kuwait, Oman, Qatar and UAE. However, during the first period, shocks to Bahraini stock market induce a negative impact on oil returns, while no reaction is found whatever the shocks. Regarding the case of negative oil shocks, the results for the case of oil return shocks hold for all countries, except for Bahrain where the first-period impulse response becomes negative for both oil and stock returns. More significant changes are observed when using the net oil shocks to conduct the impulse response analysis, as compared to the reported findings (i.e., the case of oil returns). Indeed, for Bahrain and Kuwait, we observe positive reaction, whereas the latter becomes negative for Saudi Arabia. Once again, these findings remain unchanged when world market returns and interest rate are controlled for.

[11] Detailed results can be made available under request.

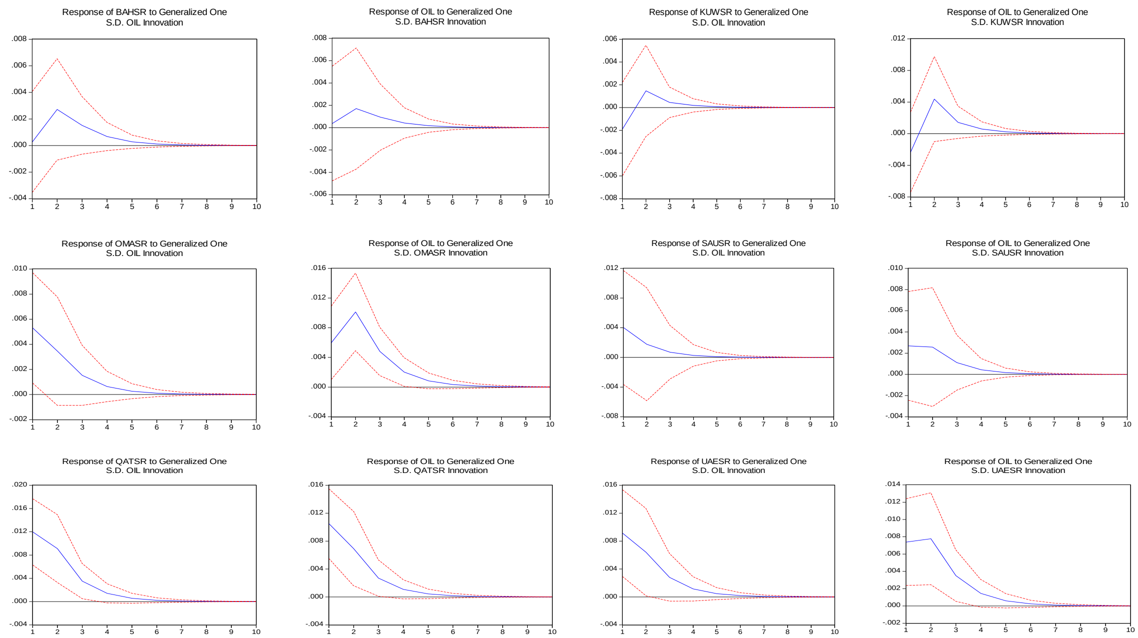

Figure 2. Impulse Response Functions of Stock and Oil Returns

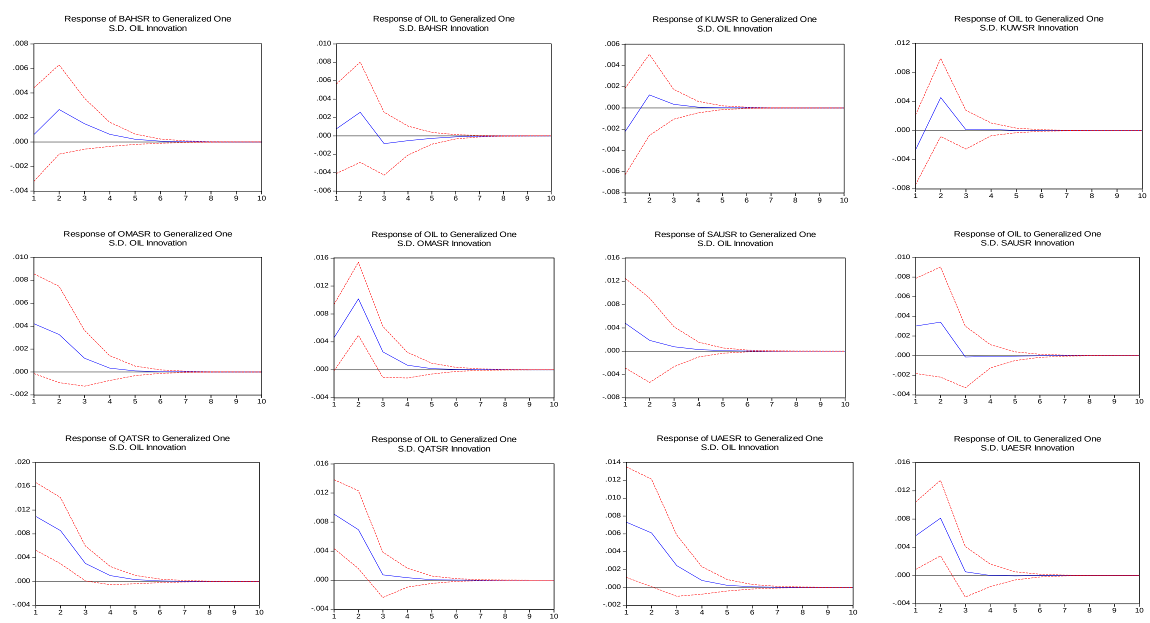

Figure 3. Impulse Response Functions of Stock and Oil Returns in Presence of Control Variables

To sum up, our analysis shows some evidence of positive short-term relationships between oil price changes and stock market returns in most GCC countries. However, both the Granger causality tests and impulse response analysis reveal the fact that considering the raw, positive, negative or net returns on world oil market index affects the obtained results, and consequently the conclusions of the study. In the following section, we investigate the long-term linkages between oil prices and stock markets in the GCC countries.

3.3 Long-term Analysis Based on Johansen's Cointegration Tests

The linear cointegration introduced by Granger (1981) and developed by Engle and Granger (1987), and Johansen (1988), among others, indicates that two integrated series of order one, I(1), X_t and Y_t (i.e., two interest rate series) can evolve together in the long run if a linear combination between them is stationary. Two series are said to be cointegrated in this case and the theory suggests the existence of a long-run equilibrium to which the system converges over time.

The Engle and Granger (1987) analysis of cointegration suffers, however, from a major methodological limitation since it only permits to examine a unique cointegrating vector at a time. To the extent that multiple cointegrating vectors may exist simultaneously, information about the real linkages among considered variables can be lost due to the restriction of a bilateral relationship. That is why we decided to employ the multivariate cointegration framework, developed by Johansen (1988), to test for cointegration between oil and stock prices.

Table 10. Johansen's Cointegration Tests Applied to Oil and Stock Markets: Country by Country Analysis

	Model without trend		**Model with trend**	
	Λ_{max}*	Trace	Λ_{max}	Trace
Bahrain				
H0 : r = 0 vs. H1 : r > 0	12.901	14.174	12.538	13.803
H0 : r = 1 vs. H1 : r = 2	1.273	1.273	1.265	1.265
Kuwait				
H0 : r = 0 vs. H1 : r > 0	11.005	14.300	10.633	13.366
H0 : r = 1 vs. H1 : r = 2	3.295	3.295	2.734	2.734
Oman				
H0 : r = 0 vs. H1 : r > 0	6.972	8.106	6.697	7.823
H0 : r = 1 vs. H1 : r = 2	1.134	1.134	1.126	1.126
Qatar				
H0 : r = 0 vs. H1 : r > 0	3.304	4.969	2.980	4.417
H0 : r = 1 vs. H1 : r = 2	1.566	1.566	1.438	1.438
Saudi Arabia				
H0 : r = 0 vs. H1 : r > 0	2.743	5.445	2.713	4.762
H0 : r = 1 vs. H1 : r = 2	2.702	2.702	2.049	2.049
UAE				
H0 : r = 0 vs. H1 : r > 0	4.250	6.936	2.706	4.645
H0 : r = 1 vs. H1 : r = 2	2.686	2.686	1.938	1.938

Notes: Λ_{max} is the likelihood ratio test based on the maximal eigen value of the stochastic matrix. Trace is the empirical statistic of the likelihood test based on the trace of the stochastic matrix. At the 5% level, the critical values of the trace test are 20.261 (H0: r = 0 vs. H1: r > 0) and 9.164 (H0: r = 1 vs. H1: r = 2) for the model without trend, and 15.494 (H0: r = 0 vs. H1: r > 0) and 3.841 (H0: r = 1 vs. H1: r = 2) for the model with trend, where r is the number of cointegration relations. At the 5% level, the critical values of the maximum eigenvalue test are 15.892 (H0: r = 0 vs. H1: r = 1) and 9.164 (H0: r = 1 vs. H1: r = 2) for the model without trend, and 14.264 (H0: r = 0 vs. H1: r = 1) and 3.841 (H0: r = 1 vs. H1: r = 2) for the model with trend.

* For the Λ_{max} test, the first hypothesis test consists in testing H0: r = 0 vs. H1: r = 1.

The results reported in Table 10 show that there is no cointegration between oil and stock markets of the GCC countries. This finding points to the absence of long-run equilibrium between the evolutions of oil and stock prices in the GCC countries, i.e., information contained in oil prices does and not help to predict long-term movements in stock prices and inversely. Also these two markets must be treated as independent over the long-run and a VAR model is sufficient for modelling their short-term linkages. Note finally that very similar results were obtained when adding the MSCI world index and the US T-bill interest rate as control variables.

3.4 Robustness Check of the Long-run Results Using ARDL Models

This subsection provides a robustness check of the cointegration results we have previously presented. To this end, we benchmark our methodology against the autoregressive distributed lag modeling approach (ARDL).[12] This approach, proposed by Pesaran and Pesaran (1997) and Pesaran *et al.* (2001), is commonly used to examine the long-run relationships between non-stationary variables and their cointegration is equivalent to an error-correction model. At the empirical stage, we first test for cointegration between our variables of interest (oil and stock prices) based on the ARDL model. Let's consider the following unrestricted regressions:

$$\Delta LStock = \alpha_s + \sum_{i=1}^{p} a_{is}\Delta LStock_{t-i} + \sum_{i=0}^{p} b_{is}\Delta LOil_{t-i} + \sum_{i=0}^{p} c_{is}\Delta LMSCI_{t-i} + \sum_{i=0}^{p} d_{is}\Delta LInterest_{t-i} + \lambda_{1s}LStock_{t-1} + \lambda_{2s}LOil_{t-1} + \lambda_{3s}LMSCI_{t-1} + \lambda_{4s}LInterest_{t-1} + u_{1t} \quad \text{... (1)}$$

$$\Delta LOil = \alpha_o + \sum_{i=1}^{p} a_{io}\Delta LOil_{t-i} + \sum_{i=0}^{p} b_{io}\Delta LStock_{t-i} + \sum_{i=0}^{p} c_{io}\Delta LMSCI_{t-i} + \sum_{i=0}^{p} d_{io}\Delta LInterest_{t-i} + \lambda_{1o}LOil_{t-1} + \lambda_{2o}LStock_{t-1} + \lambda_{3o}LMSCI_{t-1} + \lambda_{4o}LInterest_{t-1} + u_{2t} \quad \text{... (2)}$$

where $\Delta LStock$, $\Delta LOil$, $\Delta LMSCI$ and $\Delta LInterest$ are changes in the natural logarithm of the stock price, the Brent oil price, the index price of the MSCI world stock market index, and the US 1-month Treasury bill interest rate. The null hypothesis of no cointegration among the variables, represented respectively by $F(LStock|LOil, LMSCI, LInterest)$ and $F(LOil|LStock, LMSCI, LInterest)$, cannot be rejected if $\lambda_{1j} = \lambda_{2j} = \lambda_{3j} = \lambda_{4j} = 0$ for $j = s, o$.

The estimated F-statistics for assessing the long-run relationships among the considered variables for the six GCC countries are given in Table 11.[13] For the model without control variables, the results indicate a long-run relationship for Kuwait when oil price is used as dependent variable. This finding suggests that the local stock price is the long-run forcing variable of the oil price. When the effects of the world stock market fluctuations and US T-bill interest rate are controlled for, we find at least one cointegrating vector among the oil price, the stock price,

[12] We are particularly grateful to an anonymous referee for this valuable suggestion.

[13] For models without control variables, we only have two equations in the system including the stock index and the oil price as variables, and the null hypothesis is denoted by $F(LStock|LOil)$ and $F(LOil|LStock)$.

and the control variables for in four GCC countries: Oman, Qatar, Saudi Arabia and UAE. The local stock price plays the role of long-run forcing variable together with the control variables towards the oil price. Inversely, the oil price only drives the local stock price over the long-run in the case of Oman. No long-run relationships are found for Bahrain and Kuwait.

Table 11. Results of the Bounds Testing Approach to the Analysis of Level Relationships

	F-statistics		*F-statistics*
Bahrain		**Bahrain**	
$F(LStock \mid LOil)$	1.476	$F(LStock \mid LOil, LMSCI, LInterest)$	1.994
$F(LOil \mid LStock)$	3.439	$F(LOil \mid LStock, LMSCI, LInterest)$	2.373
Kuwait		**Kuwait**	
$F(LStock \mid LOil)$	1.667	$F(LStock \mid LOil, LMSCI, LInterest)$	1.795
$F(LOil \mid LStock)$	6.430**	$F(LOil \mid LStock, LMSCI, LInterest)$	2.952
Oman		**Oman**	
$F(LStock \mid LOil)$	1.148	$F(LStock \mid LOil, LMSCI, LInterest)$	4.128*
$F(LOil \mid LStock)$	2.799	$F(LOil \mid LStock, LMSCI, LInterest)$	4.402*
Qatar		**Qatar**	
$F(LStock \mid LOil)$	2.399	$F(LStock \mid LOil, LMSCI, LInterest)$	2.518
$F(LOil \mid LStock)$	1.343	$F(LOil \mid LStock, LMSCI, LInterest)$	4.494**
Saudi Arabia		**Saudi Arabia**	
$F(LStock \mid LOil)$	0.903	$F(LStock \mid LOil, LMSCI, LInterest)$	0.935
$F(LOil \mid LStock)$	0.910	$F(LOil \mid LStock, LMSCI, LInterest)$	7.139***
UAE		**UAE**	
$F(LStock \mid LOil)$	0.521	$F(LStock \mid LOil, LMSCI, LInterest)$	1.513
$F(LOil \mid LStock)$	1.233	$F(LOil \mid LStock, LMSCI, LInterest)$	5.042**

Notes: Without control variables, the critical values from Pesaran *et al.* (2001) are 4.78 (10%), 5.73 (5%) and 7.84 (1%), while they are 3.77 (10%), 4.35 (5%) and 5.61 (1%) for models with control variables. *, **, and * indicate significance at 10%, 5% and 1% levels respectively.

We now turn to estimate the short- and long-run coefficients for the models where cointegrating relationships are found (Table 11). We consider the following ARDL$(p, p_1, \ldots, p_k)$ model (Pesaran and Pesaran 1997):

$$\Phi(L,p)\,y_t = \alpha_0 + \sum_{i=1}^{k} \beta_i(L,p_i)\,x_{it} + \gamma' v_t + \varepsilon_t \qquad \ldots (3)$$

where $\Phi(L,p) = 1 - \varphi_1 L - \varphi_2 L^2 - \cdots - \varphi_p L^p$ and $\beta_i(L,p_i) = \beta_{i0} + \beta_{i1} L + \beta_{i2} L^2 + \cdots + \beta_{ip_i} L^{p_i}$ for $i = 1, 2, \ldots, k$. Note that y_t is a chosen dependent variable, x_{it} is the *i*th independent variable, and v_t is a deterministic vector of variables. Given a maximum lag length m, the optimal lag lengths $\hat{p}$ and

$\hat{p}_i$ $(i = 1, 2, \ldots, k)$ are selected using the Schwarz Bayesian criterion by estimating $(m+1)^{k+1}$ regressions. After selecting the appropriate model, the long-run coefficients for the response of an endogenous variable to a change in a forcing variable are computed as follows:

$$\hat{\mu}_i = \frac{\hat{\beta}_{i0} + \hat{\beta}_{i1} + \hat{\beta}_{i2} + \cdots + \hat{\beta}_{i\hat{p}_i}}{1 - \hat{\varphi}_1 - \hat{\varphi}_2 - \cdots - \hat{\varphi}_{\hat{p}}}, \qquad i = 1, 2, \ldots, k \qquad \ldots (4)$$

The estimates of the long-run coefficients are reported in Table 12. We find evidence of a significant transmission of price information at the 1% level from the Kuwaiti stock market to the Brent oil price. For Oman, the results indicate no significant impact from the independent variables (oil and control variables) when local stock price is used as the dependent variable in the long-run relationship. In the second cointegration relationships, local stock price in Oman and MSCI world market price index are found to be relevant drivers of the oil price change. The same result is found for Qatar. For Saudi Arabia and UAE, local stock price and MSCI world market price index have a positive long-run impact on the oil price, while the interest rate negatively affects the oil price. The impact of interest rate is explainable since higher interest rate tends to reduce industrial activity and, in turn, leads to lower the oil price. We note finally that the MSCI world price index has generally stronger impact on the oil price than the local stock price does.

We finally introduce the detected cointegrating relationships into an error-correction model (ECM) in order to simultaneously investigate the short- and long-run links between variables. This procedure also permits to draw conclusions about the dynamic adjustments of short-term deviations of system variables from their long-run state. We consider the following error-correction specification associated with the appropriate ARDL:

$$\Delta y_t = -\left(1 - \hat{\varphi}_1 - \hat{\varphi}_2 - \cdots - \hat{\varphi}_{\hat{p}}\right) ECM_{t-1} + \sum_{i=1}^{k} \beta_{i0} \Delta x_{it} + \gamma' \Delta v_t - \sum_{j=1}^{\hat{p}-1} \varphi_j^* \Delta y_{t-j} - \sum_{i=1}^{k} \sum_{j=1}^{\hat{p}_i - 1} \beta_{ij}^* \Delta x_{i,t-j} + \varepsilon_t \qquad \ldots (5)$$

where $ECM_t = y_t - \sum_{i=1}^{k} \hat{\mu}_i x_{it} - \hat{\eta}' v_t$, $\hat{\eta}$ are the long-run coefficients associated with the vector of variables v_t. φ_j^* and β_{ij}^* are the short-run dynamic parameters. The estimation results, reported in Table 13, clearly indicate a tendency of return to the long-run equilibrium as the error-correction terms are all negative. The only exception is the Omani case where local stock returns are used as dependent variable. For Kuwait, the adjustment of the oil price to the long-run equilibrium is driven by its one-period lagged short-run value as well as change in the local stock prices. For Oman (oil returns as dependent variable) and Qatar, lagged oil returns, local stock returns and world stock market returns on MSCI world market index positively influence the long-run convergence of oil returns. Similar findings are obtained for Saudi Arabia and UAE. We also observe that over the short-run almost all the variables affect positively and significantly oil price changes. The adjustment speed is the same for Qatar and Saudi.

Table 12. Long-run Coefficient Estimates for the Model with Cointegrated Relationships

	Coefficient	*Standard error*	*T-statistics (Prob.)*
Kuwait			
$F(LOil \mid LStock)$ [a]			
LStock	1.320	0.319	4.139 (0.000)
Intercept	-2.339	1.600	-1.462 (0.146)
Oman			
$F(LStock \mid LOil, LMSCI, LInterest)$ [b]			
LOil	0.635	1.117	0.568 (0.571)
LMSCI	5.044	7.963	0.633 (0.527)
Linterest	-0.005	0.616	-0.008 (0.994)
Intercept	-22.521	39.161	-0.575 (0.566)
$F(LOil \mid LStock, LMSCI, LInterest)$ [c]			
LStock	0.978	0.324	3.021 (0.003)
LMSCI	1.470	0.452	3.253 (0.001)
Linetrest	0.042	0.163	0.258 (0.797)
Intercept	-7.442	2.719	-2.737 (0.007)
Qatar			
$F(LOil \mid LStock, LMSCI, LInterest)$ [d]			
LStock	0.884	0.326	2.710 (0.007)
LMSCI	2.600	0.740	3.514 (0.001)
Linterest	0.027	0.180	0.147 (0.883)
Intercept	-12.435	4.902	-2.537 (0.012)
Saudi			
$F(LOil \mid LStock, LMSCI, LInterest)$ [e]			
LStock	0.907	0.365	2.488 (0.014)
LMSCI	3.842	1.145	3.354 (0.001)
Linterest	-0.373	0.101	-3.685 (0.000)
Intercept	-17.936	7.046	-2.545 (0.012)
UAE			
$F(LOil \mid LStock, LMSCI, LInterest)$ [f]			
LStock	0.923	0.448	2.060 (0.041)
LMSCI	3.246	1.087	2.986 (0.003)
Linetrest	-0.236	0.140	-1.686 (0.094)
Intercept	-15.282	7.056	-2.166 (0.032)

Notes: [a] LOil is the dependent variable in the long-run relationship. The selected model is an ARDL (2, 0).
[b] LStock is the dependent variable in the long-run relationship. The selected model is an ARDL (1, 0, 2, 0).
[c] LOil is the dependent variable in the long-run relationship. The selected model is an ARDL (2, 0, 0, 1).
[d] LOil is the dependent variable in the long-run relationship. The selected model is an ARDL (2, 1, 0, 1).
[e] LOil is the dependent variable in the long-run relationship. The selected model is an ARDL (2, 0, 0, 1).
[f] LOil is the dependent variable in the long-run relationship. The selected model is an ARDL (2, 0, 0, 1).

Table 13. Error-Correction Representation for the Selected ARDL Models

	Coefficient	*Standard error*	*T-statistic (Prob.)*
Kuwait			
DLOil: Dependent variable [a]			
DLOil1	0.357	0076	4.705 (0.000)
DLStock	0.059	0.021	2.833 (0.005)
DIntercept	-0.105	0.071	-1.479 (0.141)
ECM(-1)	-0.045	0.015	-3.035 (0.003)
Oman			
DLStock: Dependent variable [b]			
DLOil	0.008	0.018	0.463 (0.644)
DLMSCI	0.321	0.079	4.088 (0.000)
DLMSCI1	0.194	0.086	2.254 (0.026)
DLInterest	-0.000	0.008	-0.008 (0.994)
DIntercept	-0.298	0.110	-2.699 (0.008)
ECM(-1)	-0.013	0.020	-0.666 (0.507)
DLoil: Dependent variable [c]			
DLOil1	0.272	0.075	3.644 (0.000)
DLStock	0.067	0.023	2.948 (0.004)
DLMSCI	0.100	0.028	3.641 (0.000)
DLInterest	0.059	0.023	2.624 (0.010)
DIntercept	-0.507	0.120	-4.213 (0.000)
ECM(-1)	-0.068	0.021	-3.250 (0.001)
Qatar			
DLOil: Dependent variable [d]			
DLOil1	0.225	0.075	2.987 (0.003)
DLStock	0.210	0.066	3.201 (0.002)
DLMSCI	0.136	0.033	4.152 (0.000)
DLInterest	0.001	0.009	0.154 (0.878)
DIntercept	-0.650	0.157	-4.130 (0.000)
ECM(-1)	-0.052	0.020	-2.625 (0.010)
Saudi Arabia			
DLOil: Dependent variable [e]			
DLOil1	0.227	0.075	3.029 (0.003)
DLStock	0.047	0.012	3.802 (0.000)
DLMSCI	0.198	0.036	5.580 (0.000)
DLInterest	0.044	0.023	1.946 (0.053)
DIntercept	-0.925	0.184	-5.021 (0.000)
ECM(-1)	-0.052	0.018	-2.801 (0.006)
UAE			
DLOil: Dependent variable [f]			
DLOil1	0.239	0.076	3.145 (0.002)
DLStock	0.042	0.013	3.160 (0.002)
DLMSCI	0.147	0.030	4.960 (0.000)
DLInterest	0.049	0.023	2.132 (0.035)
DIntercept	-0.693	0.152	-4.550 (0.000)
ECM(-1)	-0.045	0.018	-2.456 (0.015)

Notes: [a] The selected model is an ARDL (2, 0). [b] The selected model is an ARDL (1, 0, 2, 0). [c] The selected model is an ARDL (2, 0, 0, 1). [d] The selected model is an ARDL (2, 1, 0, 1). [e] The selected model is an ARDL (2, 0, 0, 1). [f] The selected model is an ARDL (2, 0, 0, 1).

4. Implications of the Results

Theoretically, stock returns are impacted by oil price changes through their effects on both expected cash-flows and discount rate. In the last decade, researchers and market participants have thus attempted to find a practical framework that identifies how oil prices affect stock markets. However, they do not reach any general consensus. Using several econometric techniques, our empirical results show strong causal linkages in the short-run between oil and stock markets in the GCC countries with the impact direction running usually from oil to stocks. Stock returns seem also to be more sensitive to negative than to positive oil shocks. When the autoregressive distributed lags model is used, we find several significant long-run relationships between oil and stock prices. Our findings are not unexpected given the fact that GCC countries are heavily dependent on oil export (and thus sensitive to changes in oil prices) and have similar economic structures.

Our results have, therefore, several important implications. First, they suggest that international diversification benefits can be achieved by including assets from both net oil-importing countries (e.g., most developed countries) and net oil-exporting countries (e.g., GCC countries). In fact, a portfolio made up of assets with both positive and negative sensitivities to oil is weakly affected by oil price shocks. Alternatively, global investors may consider hedging for oil price shocks using oil-based derivatives. Moreover, given the asymmetry characterizing the oil-stock relationship in the GCC countries, investors and portfolio managers should rebalance their portfolios with respect to the expected signs of oil price changes (rise or fall).

Second, the significant relationship between oil prices and stock markets over the short-run implies some degree of predictability in the GCC stock markets. One may thus predict, based on demand and supply expectations in oil and oil related products markets, the evolution of oil prices as well as their effects on stock prices in the GCC countries. Accordingly, profitable speculation and arbitrage strategies can be built on the basis of our results.

Third, the existence of a long-run relationship between oil prices and stock prices in the GCC countries suggests, from the perspective of investments, that oil and stock market can be considered as integrated rather segmented markets, implying that expected diversification benefits from holding oil and stocks in the GCC countries are diminishing. Thus, local investors should seek new investment opportunities outside the region. Inversely, global investors from developed and emerging markets can invest a portion of their wealth in the GCC countries if they want to reduce the effects of oil price rises on their profitability.

Finally, our results show that oil price changes significantly affect stock markets in the GCC countries. Since stock markets are the barometer of economic activity and are strongly related to consumer and investor confidence, GCC countries as major OPEC policymakers should pay attention to the potential impacts of their actions on oil prices and to the effects of oil price fluctuations on their own economies and stock markets.

5. Conclusion

The aim of this paper was to investigate the dynamic relationships between oil prices and GCC stock markets using different econometric techniques. Our short-term analysis shows some evidence of positive links between the two variables. The effects of oil price changes on stock returns in the GCC countries seem to be asymmetric: negative oil price changes have larger impact on stock returns than positive oil price changes. Moreover, the results indicate that when causality exists, it runs from oil prices to stock markets in most cases. The standard cointegration analysis reveals no long-term relationship between oil prices and stock markets in the GCC countries. We also estimated the popular autoregressive distributed lags model to empirically check the robustness of the cointegration findings from Johansen (1988)'s procedure. The results point to the existence of several cointegrating relationships where local stock price, MSCI world market price index, and US T-bill interest rate are forcing variables of the oil price. We finally find a tendency of return to long-run equilibrium for almost all cases. Overall, our results are of great interest to researchers, regulators, and market participants as discussed in Section 4.

Our study also offers several avenues for future research. First, the relationships between oil price changes and stock market returns in the GCC countries can be expected to vary from one economic sector to another. A sector analysis of this link would be informative. Second, empirical evidence from international equity markets and other regions should be produced to examine the robustness of the findings. Finally, the methods we use in this article could be used to examine the effects of other energy products.

References

Anoruo, E. and M. Mustafa (2007) "An Empirical Investigation into the Relation of Oil to Stock Market Prices", *North American Journal of Finance and Banking Research*, 1(1), 22-36.

Basher, S.A. and P. Sadorsky (2006) "Oil Price Risk and Emerging Stock Markets", *Global Finance Journal*, 1(2), 224-251.

Breitung, J. (2001) "Rank Tests for Nonlinear Cointegration", *Journal of Business and Economic Statistics*, 19(3), 331-340.

Breitung, J. and C. Gourieroux (1997) "Rank Tests for Unit Roots", *Journal of Econometrics*, 81(1), 7-27.

Ciner, C. (2001) "Energy Shock and Financial Market Nonlinear Linkages", *Studies in Nonlinear Dynamics and Econometrics*, 5(3), 203-212.

Cologni, A. and M. Manera (2009) "The Asymmetric Effects of Oil Shocks on Output Growth: A Markov-switching Analysis for the G-7 Countries", *Economic Modelling*, 26(1), 1-29.

Cologni, A. and M. Manera (2008), "Oil Prices, Inflation and Interest Rates in a Structural Cointegrated VAR Model for the G-7 Countries", *Energy Economics*, 30(3), 856-888.

Cunado, J. and F. Perez de Garcia (2005) "Oil Prices, Economic Activity and Inflation: Evidence for Some Asian Countries", *Quarterly Review of Economics and Finance*, 45(1), 65-83.

El-Sharif, I., D. Brown, B. Burton, B. Nixon, B. and Alex Russell (2005) "Evidence on the Nature and Extent of the Relationship between Oil Prices and Equity Values in the UK", *Energy Economics*, 27(6), 819-830.

Hamilton, J.D. (2003) "What is an Oil Shock?", *Journal of Econometrics*, 113(2), 363-98.

Hamilton, J.D. (1983) "Oil and the Macroeconomy since World War II", *Journal of Political Economy*, 91(2), 228-248.

Hammoudeh, S. and E. Aleisa (2004) "Dynamic Relationship among GCC Stock Markets and NYMEX Oil Futures", *Contemporary Economic Policy*, 22(2), 250-269.

Hammoudeh, S. and K. Choi (2006) "Behavior of GCC Stock Markets and Impacts of US Oil and Financial Markets", *Research in International Business and Finance*, 20(1), 22-44.

Hammoudeh, S., S. Dibooglu and Eisa Aleisa (2004) "Relationships among US Oil Prices and Oil Industry Equity Indices", *International Review of Economics and Finance*, 13(4), 427-453.

Huang, R.D., R.W. Masulis and Hans R. Stoll (1996) "Energy Shocks and Financial Markets", *Journal of Futures Markets*, 16(1), 1-27.

Jones, C.M.and G. Kaul, G (1996) "Oil and the Stock Markets", *Journal of Finance*, 51(2), 463-491.

Lardic, S. and V. Mignon (2008) "Oil Prices and Economic Activity: An Asymmetric Cointegration Approach", *Energy Economics*, 30(3), 847-855.

Maghyereh, A. and A. Al-Kandari (2007) "Oil Prices and Stock Markets in GCC Countries: New Evidence from Nonlinear Cointegration Analysis", *Managerial Finance*, 33(7), 449-460.

Maravall, A. and D. Peña (1992) *Missing Observations and Additive Outliers in Time Series Models*, Working Paper 92-40, Statistics and Econometrics Series 28, Universiy Carlos III of Madrid.

Papapetrou, E. (2001) "Oil Price Shocks, Stock Market, Economic Activity and Employment in Greece", *Energy Economics*, 23(5), 511-532.

Park, J. and R.A. Ratti (2008) "Oil Price Shocks and Stock Markets in the US and 13 European Countries", *Energy Economics*, 30(5), 2587-2608.

Pesaran, M.H. and B. Pesaran (1997) *Working with Microfit 4.0*, Cambridge: Camfit Data Ltd.

Pesaran, M.H., Y. Shin, and Richard J. Smith (2001) "Bounds Testing Approaches to the Analysis of Level Relationships", *Journal of Applied Econometrics*, 16(3), 289–326.

Sadorsky, P. (1999) "Oil Price Shocks and Stock Market Activity", *Energy Economics*, 21(5), 449-469.

Zarour, B.A. (2006) "Wild Oil Prices, but Brave Stock Markets! The Case of GCC Stock Markets", *Operational Research*, 6(2), 145-162.

Zhang, D. (2008) "Oil Shock and Economic Growth in Japan: A Nonlinear Approach", *Energy Economics*, 30(5), 2374-2390.

♦♦♦